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COUNTY STANDARDS FOR SITE SPECIFIC HYDROGEOLOGIC INVESTIGATIONS

These standards supplement the County of San Diego's Groundwater Ordinance No. 7994 (New Series), which was approved by the Board of Supervisors in October 1991. The standards are intended to assist professionals involved in conducting hydrogeologic investigations to evaluate groundwater availability in San Diego County. The standards constitute the basis for review of all groundwater reports submitted to the County for approval. Such reports are required for proposed projects that are determined by the Director of the Department of Planning and Land Use, hereafter referred to as the Director, or other hearing body, to potentially impact groundwater in accordance with the Groundwater Ordinance. The Director may designate the County Groundwater Geologist as the employee responsible for implementing these standards.

These standards have been prepared considering the local hydrogeologic conditions in San Diego County and experience gained from groundwater reports previously submitted to the County. The standards are intended to be a general and flexible guide and should not be considered as rigid instructions. Very few, if any, projects will be required to provide all of the information outlined within this document. The specific requirements discussed in this document may be waived on particular projects if, in the opinion of the Director or his representative, such waiver is technically justified. Consultation with the County prior to the commencement of groundwater investigations is strongly recommended to verify that the proposed investigations are consistent with these standards and the requirements of the specific project. It is also advisable to request a "scoping" letter from the Director or his representative which specifies the requirements of the investigation.

The following information and analyses are required for an objective evaluation of the long-term groundwater availability for projects in San Diego County. The methods and data collection procedures followed and the data obtained and used in the analyses will be subject to the discretionary review and evaluation by the Director or his representative.

1. DESCRIPTION OF PROJECT SITE AND EXISTING DEVELOPMENT

- 1.1 The report shall present a description of the project and indicate, using text and maps, the location and the site configuration within the topographic watershed. It shall also include a description of site

topography and surface drainage patterns. Information available from published reports and maps for the general project site area can be used if the data is verified by field observations.

- 1.2 The report should include a description of the soil types. In the absence of a detailed site-specific soil investigation, descriptions based on the maps and other soil information provided by the Soil Conservation Service (SCS) "Soil Survey" for San Diego County will be considered adequate, provided that the data is verified by field observations.
- 1.3 The report shall describe the geologic setting of the project site, including a geologic map showing any outcrops, major structural features and a generalized geologic section. It is desirable that groundwater levels and gradient over the project site area and vicinity be shown. Data sources may include the logs of test borings and existing wells. Regional geologic maps and sections from previous studies may be acceptable but field visit confirmation of geologic information is required. Additionally, drilling in selected locations within the project may be required by the County as stipulated within Section 67.722,C of the Groundwater Ordinance.
- 1.4 The report shall include information on the existing land use at the project site. If the proposed project is a "water intensive use" (as defined within the Groundwater Ordinance) or is within a mapped impacted groundwater basin, the report should include the following information 1) the ultimate development capacity of the basin based on the existing legal lots, 2) the maximum allowable density permitted by the County General Plan, and 3) the number of existing legal lots within the watershed, including estimates of the percentage of the existing legal lots that have been developed and the sizes of developed lots.

2. INVENTORY OF EXISTING WATER SOURCES AND USES

- 2.1 An inventory shall be conducted of all the wells, springs, surface ponds and reservoirs, and any other water sources located at the project site. The inventory shall include sufficient information to document the presence of water sources, their location, production characteristics, water quality, and existing water use. Off-site water sources that could affect the proposed project (i.e., subsurface flow from adjacent undevelopable land, etc.) should be indicated. Nearby high demand water consumers should also be noted.
- 2.2 The performance records of all of the existing wells located within the watershed, including well failures and causes of failure, should be documented to the extent possible.
- 2.3 The report shall evaluate the projected water use requirement throughout the project life. The basis for the estimate shall be adequately documented and shall include all projected water uses. In the case of residential development, the study shall assume an annual consumptive use requirement of 0.5 acre-feet (163,000 gallons) of water per dwelling

unit. Consumptive use is the amount of water lost from the groundwater resource due to human use, including evaporation and transpiration (plant use) losses associated with residential demand. Nonresidential uses will require a detailed analysis of anticipated water demand.

3. EVALUATION OF ON-SITE GROUNDWATER

- 3.1 The report shall evaluate and document the volume of groundwater in storage at the project site. Estimates of groundwater in storage should be made based on site-specific information and data on the saturated thickness, and specific yield of the aquifer. In the absence of site-specific data, information on the regional hydrogeologic setting and estimates of specific yield may be used. If this procedure is followed, conservative estimates of specific yield shall be used.

Where a major portion of the aquifer is granular or completely decomposed, aquifer storage coefficients generally are best determined from aquifer pumping tests. If no pumping tests have been conducted in the immediate vicinity, the Director may require that test wells be installed and tested to evaluate aquifer storage coefficients. Information obtained from wells and test borings located off the project site within the same watershed may be acceptable, depending on the size of project, total area of watershed, and the number and location of wells and test borings for which data is available.

To provide an adequate margin of safety, extractable water should be estimated at no more than 50 percent of the calculated total groundwater in storage. All groundwater in storage is not extractable due to the steep cones of depression around wells. This value of 50 percent should be considered the quantity of extractable groundwater unless data is presented which clearly demonstrates otherwise.

- 3.2 The report shall include evaluation of on-site recharge including the average annual recharge from precipitation. Recharge from artificial sources may be included, if appropriate.

- 3.2.1 The report shall include an evaluation of the long-term average annual recharge rate for the project site. Appropriate technical procedures, such as the soil moisture balance methodology, should be applied to the calculation of average annual recharge. Computer programs exist which simplify the recharge calculations. Use of these programs is permitted, provided that confirmed site-specific data is utilized. The acceptability of any computer program is the decision of the Director or his representative.

Precipitation and runoff data obtained from gaging stations located in the same watershed, preferably at or near the project site, should be used. If there is no long-term data available, the data obtained from a nearby watershed of comparable area, elevation, topography, geology, and soils may be acceptable. Under most circumstances, a continuous record

of 30 years or more, including wet and dry periods, is required.

- 3.2.2 Artificial recharge from wastewater (i.e. septic systems) return flow has been included in the 0.5 acre-feet per residence per year consumptive use estimate. Therefore, wastewater recharge may only be included in residential project recharge if (1) the water has been treated at a wastewater treatment facility or (2) if a higher consumptive use value than 0.5 acre-feet per residence per year is used. Should the 0.5 acre-feet consumptive use figure not be used, a total groundwater use rate of 0.75 acre-feet per residence shall be assumed.

4. PUMP TEST ANALYSIS

Pump tests are the procedure through which water is produced from a well and measurements are taken on a regular basis to determine well and aquifer characteristics. Overall, these tests shall comply with the minimum requirements of Section 67.703 of the Groundwater Ordinance.

- 4.1 Residential pump tests: All such tests shall satisfy all three conditions of Section 67.703, 1.a,b and c of the Groundwater Ordinance. Residential pump tests shall be completed by a registered geologist unless the conditions of Section 67.703, 2.a.b. are satisfied.
- 4.2 Nonresidential tests: Such tests shall meet the requirements of Section 67.703.3. Nonresidential tests will generally be more extensive than a residential pump test.
- 4.3 Pump Test and Analysis Performance Standards: Specific guidelines for all pump tests can not be given due to numerous aquifer testing scenarios. It is the responsibility of the groundwater professional to ensure that the pump testing and analysis are performed utilizing scientifically valid methods. The final decision of the appropriateness of a specific testing and analysis method shall be made by the Director or his representative.
- 4.3.2 A detailed description of the testing configuration and data collection methods should be included within the report. Tables and figures should be appropriately labeled and units of measurement should be consistent throughout the report. The report should clearly indicate the analysis methods used, assumptions made, raw data, and graphical output of any computer programs utilized. All data manipulation must be clearly described.
- 4.3.3 As a result of the low transmissivity of the fractured rock aquifers of San Diego County, wellbore storage often has a substantial effect upon the results of well tests. Therefore, wellbore storage effects shall be addressed in the testing of low production wells. The specific capacity of the well shall

be calculated during the test, either immediately before the completion of pumping or at least 3 hours into the production interval, to determine if continuation of the testing period is warranted.

If the calculated specific capacity of the well is less than 0.5 gallons per minute per foot of drawdown (gpm/ft) the following measures shall be performed.

4.3.1.1 For a 6-inch diameter borehole, the minimum production period shall be increased in accordance with the following table.

<u>Specific Capacity</u>	<u>Minimum Pumping Duration</u>
0.2-0.5 gpm/ft	8 hours
0.1-0.2 gpm/ft	12 hours
<0.1 gpm/ft	24 hours

At the end of any extensions in the pumping duration it must be determined if the specific capacity has been reduced to the point that an even longer pumping duration is required per the above table.

This additional production interval is required to mitigate the effect of wellbore storage on the estimate of well yield. For boreholes larger than 6-inches additional pumping duration will be required. Exceptions to these minimum pumping durations may be allowed at the discretion of the Director or his representative.

4.3.1.2 Final data analysis will require that the proper analytical techniques are utilized which account for the effects of wellbore storage.

The analysis that was performed to determine the above guidelines for minimum pumping duration is documented in Appendix A.

5. LONG-TERM GROUNDWATER AVAILABILITY

- 5.1 All investigations and reports shall evaluate the on-site groundwater availability, including the long-term annual yield (perennial yield) that can be sustained at the project site. This represents the yield that can be sustained indefinitely without resulting in permanent depletion of groundwater in storage or other detrimental effects on groundwater (i.e., water quality deterioration, etc.). The annual long-term yield should be evaluated considering extractable estimates of groundwater in storage, recoverable groundwater losses, existing on-site water withdrawals, and the expected annual recharge rates from natural and artificial sources. If the project is a "water intensive use" as defined within the Groundwater Ordinance, or if the project is located within a mapped

groundwater impacted basin, the existing basinwide groundwater withdrawals, water rights within the watershed, and maximum future withdrawals that would be allowed by the County General Plan should also be taken in consideration.

- 5.3 A groundwater balance should be conducted over a drought period such as 1955 to 1975 using estimated rates of groundwater recharge, storage and project demand. This is required to prove a viable groundwater resource during drought periods.
- 5.4 The design, discharge, number, and locations of proposed project wells should be indicated in the report. The proposed total annual extractions from all of the existing and proposed wells may not exceed the long-term yield for the project site.

6. EVALUATION OF PROJECT IMPACTS

- 6.1 The report shall evaluate impacts due to project groundwater withdrawal on water levels at the project site and subsequent impacts to baseflow, groundwater in storage, and nearby users.
- 6.2 The report shall discuss any other environmental impacts that are expected to occur due to groundwater withdrawals for project use (i.e. wetlands impacts due to water table drawdown, or water quality impacts).
- 6.3 In the event that the proposed groundwater withdrawals are significant and not mitigable, the Director will recommend against the project as proposed in accordance with the mandatory findings required by the Groundwater Ordinance.

7. IMPLEMENTATION OF THE STANDARDS

- 7.1 These standards have been adopted by the Department of Planning and Land Use on October 2, 1991. All reports submitted 45 days after this date will be required to comply with these standards.
- 7.2 Revision to these standards will be made periodically. All revisions to the standards shall be made available immediately upon adoption by the Department of Planning and Land Use and shall be effective upon completion of a 45 day public review period.

Revised November 1991

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APPENDIX A

DEVELOPMENT OF GUIDELINES TO ACCOUNT FOR WELLBORE STORAGE EFFECTS ON PUMP TEST DATA

As a result of the very low transmissivity of the bedrock aquifers of San Diego County, wellbore storage can substantially affect pump test data. Wellbore storage effects can lead to underestimation of aquifer transmissivity and well yield unless proper testing and analysis techniques are utilized. Therefore, wellbore storage effects should be accounted for in wells with low specific capacity.

In order to develop a guideline for the accounting of wellbore storage effects on pump tests a rigorous approach was necessary. The initial step was to collect a representative range of calculated transmissivities (T) within the fractured rock aquifers of the County. The range was determined from records on file at the Department of Planning and Land Use to be from 0.268 to 1336 ft²/day). From these T values the time (ts) after a pump test is initiated beyond which wellbore storage impacts are negligible were calculated for different wellbore diameters. The calculation utilized and the results are presented in Table 1.

It was recognized that the determination of T in the field during the performance of the test is difficult and subject to substantial error. In a recently written paper (Huntley, et al) transmissivity values of the bedrock aquifers of San Diego County were related to calculated 3-hour specific capacity. Utilizing the formula presented in Huntley's paper the representative specific capacity for the given range of transmissivities was calculated. The results are presented in Table 2. The 90% confidence interval for this conversion is from 25 to 400% of the calculated values. This range of calculated values is considered acceptable given the conservative nature of the calculated ts values in Table 1.

The results of the T to (Q/s) conversion were added to the second column of Table 1. The final results of the minimum pumping duration calculations are presented in Figures 1 and 2 for specific capacity and transmissivity, respectively. Since the vast majority of the wells drilled in the fractured rock aquifer are 6" diameter, the analysis will concentrate on this wellbore diameter. The determining specific capacity at which additional testing time may be required is 0.5 gpm/ft of drawdown. The following table defines the minimum pumping duration for specific capacity less than 0.5 gpm/ft.

Specific Capacity

Minimum Pumping Duration

0.2-0.5 gpm/ft
0.1-0.2 gpm/ft
<0.1 gpm/ft

8 hours
12 hours
24 hours

For tests performed in wells greater than 6" in diameter the specific capacity threshold value and pumping durations must be increased.

A quick analysis was performed to approximate the percentage of wells this requirement will effect. The data set used in (Huntley) was utilized and resulted in the following breakdown.

<u>Specific Capacity</u>	<u>Percentage of Wells</u>
>0.5 gpm/ft	55%
0.2-0.5 gpm/ft	15%
0.1-0.2 gpm/ft	20%
<0.1 gpm/ft	10%

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TABLE 1

DETERMINATION OF MINIMUM PUMPING TIME REQUIRED FOR
WELLBORE STORAGE EFFECTS TO BE NEGLIGIBLE (<1%)

from Walton (1987):

$$ts = 540000 \frac{r_w^2 - r_c^2}{T}$$

where: ts = time after pumping started beyond which wellbore storage effects are negligible (minutes)
 r_w = production well effective radius (feet)
 r_c = column pipe radius (feet) (assumed to be 0.104')
 T = Transmissivity (Gallons/Day/ft)

VALUES OF ts (minutes) FOR VARIOUS r_w AND T

		Well Effective Diameter			
T	Calculated	4 inches	6 inches	8 inches	
	(Q/s)*	($r_w = .167$ ft)	($r_w = .25$ ft)	($r_w = .333$ ft)	
2	0.015	4610	13955	26483	VALUES OF ts
4	0.026	2305	6977	13241	
8	0.048	1152	3489	6621	
10	0.058	922	2791	5297	
20	0.103	461	1395	2648	
40	0.186	230	698	1324	
60	0.263	154	465	883	
80	0.335	115	349	662	
150	0.571	61	186	353	
250	0.880	37	112	212	
375	1.241	25	74	141	
500	1.583	18	56	106	
750	2.233	12	37	71	
1250	3.442	7	22	42	
1750	4.578	5	16	30	
2500	6.193	4	11	21	
4000	9.224	2	7	13	
6000	13.006	2	5	9	
8000	16.597	1	3	7	
10000	20.052	1	3	5	

* = derived from Table 2

TABLE 2

ESTIMATION OF SPECIFIC CAPACITY BASED UPON TRANSMISSIVITY
BASED UPON HUNTLEY et al*

based upon the following equation:

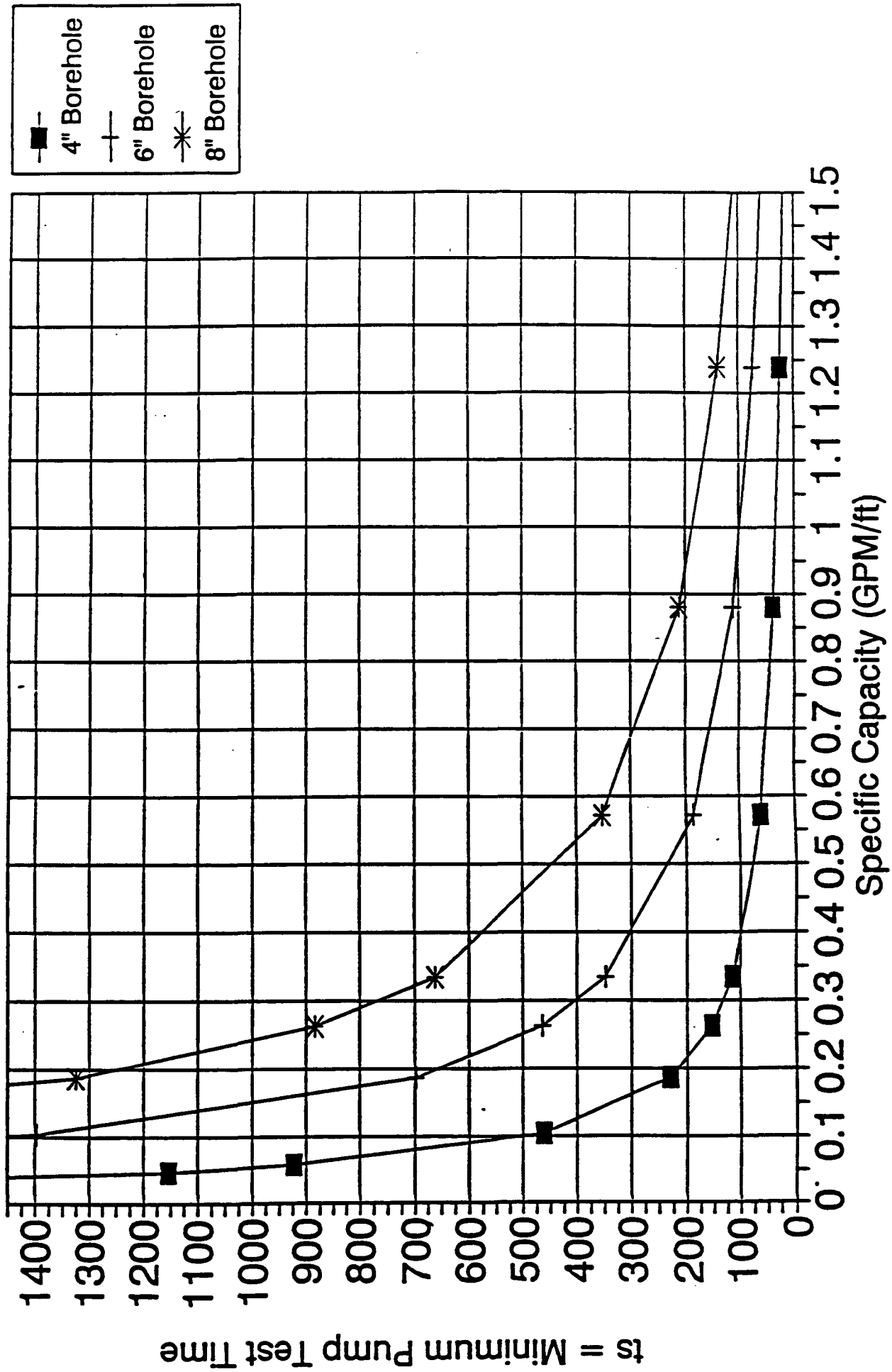
$$Q/s = \left(\frac{T}{K} \right)^{(1/1.18)}$$

where: T = Transmissivity
K = Constant (0.29 for T and Q/s in ft²/min)
Q/s = Specific Capacity of the well

TRANSMISSIVITY		3-HOUR SPECIFIC CAPACITY	
GPD/ft	ft ² /min	GPM/ft	ft ² /min
2	1.86E-04	0.015	0.0020
4	3.71E-04	0.026	0.0035
8	7.43E-04	0.048	0.0064
10	9.28E-04	0.058	0.0077
20	1.86E-03	0.103	0.0138
40	3.71E-03	0.186	0.0249
60	5.57E-03	0.263	0.0351
80	7.43E-03	0.335	0.0448
150	1.39E-02	0.571	0.0763
250	2.32E-02	0.880	0.1176
375	3.48E-02	1.241	0.1659
500	4.64E-02	1.583	0.2117
750	6.96E-02	2.233	0.2985
1250	1.16E-01	3.442	0.4602
1750	1.62E-01	4.578	0.6120
2500	2.32E-01	6.193	0.8280
4000	3.71E-01	9.224	1.2331
6000	5.57E-01	13.006	1.7388
8000	7.43E-01	16.597	2.2188
10000	9.28E-01	20.052	2.6807

* Huntley, David; R. Nommensen; and D. Steffey. 1992. The Use of Specific Capacity to Assess Transmissivity in Fractured Rock Aquifers. Ground Water.

Specific Capacity vs. Min. Pumping Time to Account for Wellbore Storage



Transmissivity vs. Min. Pumping Time to Account for Wellbore Storage

